International Journal of Obstetric Anesthesia (2014) 23, 23–28
0959-289X/$ - see front matter
http://dx.doi.org/10.1016/j.ijoa.2013.08.013

ELSEVIER
www.obstetanesthesia.com

ORIGINAL ARTICLE

An observational assessment of the sublingual microcirculation of pregnant and non-pregnant women

R.B. George,[a,b] A. Munro,[b] I. Abdo,[b,c] D.M. McKeen,[a,b] C. Lehmann[b,d,e]

[a] *Department of Women's and Obstetric Anesthesia, IWK Health Centre, Halifax, Nova Scotia, Canada*
[b] *Department of Anesthesiology, Pain Management, and Perioperative Medicine, Dalhousie University, Halifax, Nova Scotia, Canada*
[c] *Department of Anesthesiology and Intensive Care Medicine, Charles University, Prague, Faculty of Medicine in Hradec Kralove, University Hospital Hradec Kralove, Czech Republic*
[d] *Department of Pharmacology, and* [e] *Department of Microbiology and Immunology, Dalhousie University, Halifax, Nova Scotia, Canada*

ABSTRACT
Background: The microcirculation is responsible for distribution of blood within tissues, delivery of oxygen and other nutrients, and regulation of blood pressure. The objective of this study was to compare the sublingual microcirculation of pregnant participants to that of comparable non-pregnant volunteers.
Methods: Two groups of participants were recruited: a group of pregnant, non-laboring women with singleton pregnancies at term gestation and a control group of age-comparable non-pregnant volunteers. A sidestream dark field imaging device was applied to the sublingual mucosal surface obtaining a steady image for at least 20 s duration, in five visual fields. The resultant five video clips per participant were analyzed blindly and at random to prevent coupling between images. The mean microvascular flow index values for each group were compared using a paired t-test.
Results: Thirty-seven participants were recruited (19 pregnant, 18 non-pregnant); a single pregnant participant was withdrawn because of technical issues. Baseline characteristics were similar with the exception of weight and body mass index. The mean microvascular flow index was significantly higher in the pregnant group 2.7 ± 0.2 compared to the non-pregnant group 2.5 ± 0.3 ($P = 0.021$), while the perfused vessel density and proportion of perfused vessels were not significantly different ($P = 0.707$ and 0.403, respectively).
Conclusion: The microvascular flow index of pregnant women is higher than a comparable non-pregnant group, which appears to correlate with the physiological changes of pregnancy.

Keywords: Microcirculation; Pregnancy; Sidestream dark field imaging

Introduction

Physiological changes in the circulatory system enable women to adapt to the increased demands of pregnancy, labor, and delivery. The microcirculation, the small vessels of the vasculature that are embedded within organs, is responsible for the distribution of blood within tissues. The microcirculation of the endothelium provides a smooth surface for the flow of blood and regulates movement of water and dissolved materials in plasma between blood and tissues.[1] We suspect that the physiologic changes of pregnancy (elevated cardiac output and plasma volume) potentially impact the microcirculation. Therefore, physiologic and therapeutic interventions to improve organ perfusion should be accompanied by improved microvascular perfusion.

Currently, we have a limited understanding of the impact of pregnancy on vascular pathology, such as preeclampsia, on the microcirculation. Indirect measures of the reactivity of the microcirculation using iontophoresis of acetylcholine have documented changes in the microcirculation of preeclamptic women.[2–4] Sidestream dark field (SDF) imaging, a new technology, provides high-contrast images of the microcirculation and may further our understanding of its importance in healthy pregnancy. The technique uses green light that is absorbed by hemoglobin in red blood cells (RBCs) to visualize capillaries and venules.[5] Information regarding the

Accepted August 2013
Correspondence to: Dr. Ronald B. George, IWK Health Centre, Department of Women's & Obstetric Anesthesia, 5850/5980 University Avenue, P.O. Box 9700, Halifax, NS B3K 6R8, Canada.
E-mail address: rbgeorge@dal.ca

microvascular flow index (MFI) and perfused vessel density (PVD) may be invaluable clinically in determining a patient's perfusion status and need for blood transfusion.[6]

The objectives of this observational trial were to compare the sublingual microcirculation of pregnant participants to that of comparable non-pregnant volunteers and to evaluate the feasibility of a non-invasive technology, SDF imaging, in pregnant and non-pregnant participants.

Methods

The protocol was approved by the Izaak Walton Killam (IWK) Health Centre Research Ethics Board (IWK Health Centre REB# 1007223). Written informed consent was obtained from all participants meeting inclusion criteria.

Women >18 years of age, American Society of Anesthesiologists physical status I–II, with an uncomplicated, singleton, non-laboring, pregnancy at 36–40 weeks of gestation were recruited into the pregnant group. The non-pregnant group was made up of healthy female volunteers who responded to notices posted within the hospital and were interested in participating in a research study. These volunteers had never been pregnant and were matched to pregnant patients for age $\pm$ 1 year. Participants were excluded if they had known hypertensive disease, cardiovascular disease, diabetes mellitus, were obese (body mass index (BMI) >35 kg/m^2), or were smokers.

Study investigators performed all analytical non-invasive SDF measurements (MicroScan, MicroVision Medical, Amsterdam, The Netherlands). Microcirculatory parameters (MFI, PVD, proportion of perfused vessels [PPV], and total vessel density [TVD]) were measured by applying the SDF light emitting diode (LED) probe on the sublingual mucosal surface of each participant (Fig. 1). All participants were in the sitting position. Images were captured as suggested by De Backer et al.[5] The five keys to optimal image acquisition are avoidance of pressure artefacts, elimination of secretions, adequate focus and contrast adjustment, high-quality video recording and using five imaging sites per subject.[5] After gentle cleansing the sublingual surface of the oral mucosa with isotonic saline-drenched gauze, the SDF device equipped with sterile LED probe cap was applied, avoiding pressure artefacts and obtaining steady images of at least 20 s duration. Orientation of the probe was altered between data recording to obtain the best imaging quality. Images were stored on digital videotape. Recording times of 20 s provide the most relevant data while maintaining the quality of the images.[5] In each participant, recordings were captured in five visual fields with minimal intervals between the five recordings.

Fig. 1 The SDF device applied to the sublingual mucosal surface of a patient. (Reprinted with permission from Dr. Nathan Shapiro, MD, Beth Israel Deaconess Medical Center, Boston, MA, USA.)

Video clips were captured and analyzed by the same, single investigator. Video images, which contained no identifiable information, were analyzed at random to prevent coupling between images. An investigator not involved with video analysis completed the randomization with a computer generated randomization table. Sidestream dark field images were analyzed using Automated Vascular Analysis (AVA)® software (MicroVision Medical, Amsterdam, The Netherlands) which generated the MFI, PPV, PVD, and TVD (Appendix A).

Statistical analysis

Demographic and clinical data are presented as mean and standard deviation (SD). Mean MFI values for each individual were analyzed using paired Student's t and Welch's t-tests for differing variances. Our primary outcome was the difference between the MFI in our two groups. A power calculation was performed for the difference between two independent means using an MFI SD of 0.8 (approximately 15% of the mean from previous experiences in experimental measurements of mucosal functional capillary density):[7] effect size 1.125, number of groups 2, alpha 0.05, power 0.8. Fourteen participants per group were required to achieve 80% power. To address our assumptions, potential drop-outs, the non-invasive nature of the measurement and the available time for recruitment we used the larger independent means sample size and increased the group size by 20% to 17 participants per group.

Results

From 5 September 2011 to 19 September 2011, 37 participants were enrolled with 36 participants completing the study (Fig. 2). One participant was withdrawn from